GENERALIZATION OF MAP DETAILS WITHIN COMPUTER ASSISTED CARTOGRAPHY

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Abstract

Throughout the century many cartographers have addressed the issue of subjectivity in generalization, the metamorphasis from manual to digital techniques in cartography has resulted in the development of computer algorithms designed to replicate many tasks previously performed by humans. In manual generalization cartographers have taken an intrisically hollistic approach where, when simpilifying manuscript line, many decisions are applied al once: the important characteristics are selected, these important characteristics might be exaggerated, and the unwanted detail is elimited all in one swoop of a pen. In contrast to manual generalization the computer approach requires separate algorithm to complete each component in the process: simplification, classification, simbolization, smoothing, diplacement and enhancement. Most of the research effort on automated generalization has been directed towards areas of linear simplification.

This paper begins with a review of the principles and concepts of Generalization and proceeds with the problems inloved in automating the generalization process.

1.0 Principles And Concept of Generalisation

1.1 General

The producing a map at a smaller scale than the existing map or in construction a map from raw data, the cartographer traditionally employs subjective judgement to perform the necessary generalisation This subjectivity is an individual characteristic of generalisation will also vary among various map products. {See Steward, 1974).

Generalisation belongs to the most important decisive concepts of cartography. It is a fundamental ingredient in the preparation of maps because of the necessity of retaining legibility as the scale is reduced. In most cases the method adopted has been empirical and subjective but there is the increasing interest in objective and theoritical approaches especially since introduction of automation (computer) in cartography. Most advances have been acheved in the estimation of the number or length of features to be retained but the choice of which individual features which would make up the number is harder to define.

Generalisation plays a role even in large scale maps although this is not always realised. During surveys whether in the field or by means of aerial photograph, the smallest details are omitted and minute sinuosity in the outlines of roads, ditches, rivers etc. are straightened out. When however small-scales map are to be made from original survey maps, generalisation palys far more important role. With increasing reduction of scale more and more details have to be omitted, and the forms have to be simplified to an increasing degree.

The difference from reality widens and the total picture becomes more and more abstract.

The introduction of automation or computer assisted cartography has put forward the problem of formalisation of all generalisation frankness. The automation of generalisation depends upon the separation of the 'technical' factors from those which are subjective in nature. In terms of computer assisted generalisation of areal boundaries and linear feature symbols certain factors identified as being subjective should be utilized to control those factors defined as being objective.

1.2 Terms and Defination

The term ' generalasation ' is widely used in cartagraphy. The defination of generalisation given in Oxford Dictionary as: " to reduced to general law".... " to give general character to" .... " to base general statement upon' But in the second definition of the Oxford Dictionary defined the term as render only the typical characteristic of ".

This "rendering of typical characteristic " is much close to the concept of generalisation, for it implies selection judgement and retention of the essential elements.

According to Multilingual Dictionary of technical terms in cartography (ICA 1973) generalisation is defined as "the selection and simplified representation of details appropriate to the scale and/or purpose of a map" While most would agree thet selection, simplification at scale and map purpose are important consideration in generalisation, few would agree they are the only ones. Many would add several other aspect to the definition limits. (Maling 1956, Lundqvist 1959, Miller and Voskuil 1964 and Robinson and Sale 1969).

Alfred Hettner was one of the first to write about generalisation. He wrote, "Cartographic generalisation is altogether something quite different to what a philosopher means by Generalisation. Generalisation of a map is first of all a question of source of material. This is achieved partly by simplification of the objects on the map, partly omitting small or less interesting objects". (see Hattner, 1964).

Max Eckert described the idea of generalisation as selection and diminution of the number of features. Regarding the problem of omitting particular details the evaluation of any detail in relation to a certain scale and purpose is of the greatest. (see Eckert, 1921).

Fischer describes a generalised map as a summary if a large and more detail work, in which detail, which do not contribute to the general character are omitted.

Imhof in his article on generalisation of contours says: "Every cartographic generalisation aims to make legible image which has been reduced..." (see Imhof, 1965).

Robinson and Sale explains the word generalisation as "small scale simplification". They goes on to state that"... The selection of the important and the subordination or elimination non-essantial factors of the map data required that the map maker is well trained in each field ... to prepare maps", (see Robinson and Sale, 1969).

For Raisz has not defined the word generalisation as such, but there is a passage in his writing which reads"... in representing it in different ways he must have the ability to generalize intelligently and to make a correct selection of the essential to be shown". (see Raisz, 1948).

The are many other leading writers who have expressed similar points of views in other words.

1.3 Process Of Generalisation

Generalisation is a creative operation leaving a considerable freedom of action to the cartographer. In general, it is not subject to rules. Only for special works certain rules may be applied within the generalisation. Unless the representation is made 1:1 scale the degree of generalisation depends on the scale and purpose of the map. The purpose of a map is significant in this connection because special maps such as sea charts, aeronautical charts etc. are generalised in another way than topographic maps.

The cartographic generalisation process given in the literature are selection, simplication, classification, symbolization and induction. Robinson and Sale in the third edition of "Elemants in Cartography" defined the process of cartographic generalisation as: Simplication, classification, symbolization and induction. But the process of selection is carried before the above four processes. These processes by Robinson and Sale are non-rigorous but they are the best available. (see Robinson, Morrison and Sale, 1978).

A non-rigorous definition of generalisation and its elements is of little or of no use the purpose of map making in computer assisted cartography. Basically the non-rigorous defination is discussed after the software manipulation sequence has been selected and/or the map plotted.

To start a mapping process, initial process of selection has to take place. After this process of the selected information, simplification and classification may be performed symmetrically several times and in any order. Once these processes have been completed, symbols are assigned under the process of symbolization. The final process of induction accompanies symbolization. But if these processes of simplification, classification and symbolization are done well, then induction will enhances map's effectiveness.

1.3.1 Selection

The first step is the selection of information to be mapped. A selection of the available information is made so that it is consistent with the purpose of the map. It is the process of deciding which information will e required for the purpose. No modification of information is carried out in the process of selection. The choice is either to portray the information or not. Hence selection is associated with the spesification for map design. The process of deciding what the intent of the map is and what information is to be included it is best to satisfy that intent. This decision is two fold, first which sets of information and secondly the density of these informations. A measure of the number of units of map detail to scale of the map was contained within a proposal, by F. Topfer, in his 'Principle of Selection'. This ' principle of Selection' known as the 'Radical Law' of Cartographic generalisation has proved to be of great potential value for the derivation of smaller scale maps from large scale source material. It provides the basic principles of quantitative approach to generalisation by giving numerical values of the object to be selected and is also applicable to generalisation of outlines and linear symbols. (see Topfer and Pillewizer, 1966).

1.3.2 Simplification

The process of simplification becomes the most important in the overall generalistion transformation. Each data element or information that has been selected still possess several characteristic, that is, which to portray on the map and which to ignore. The elimination of unwanted details in the information is a form of simplification.

The principle of simplification is appropriate for:

(i) point data sets,

(ii) digitised line data, and

(iii) area data sets that consists of many small similar areas within the area to be mapped.

The determination of which specific information to be retain can be deduced from the purpose of the map and the phase assigned to the particular data distribution in the map design. This determination demands the knowledge about the information to be mapped. The determination on any computer assisted may be based on rank assigned to the various data elements or on the basis of proximity of position at the scale of the output map or some other criterion.

Hence the basic rules of simplification are to reduce confusion, enhance selected information, retain the highest possible levelof accuracy and retain the principlal elements of the original structure. (see Robinson, Morrison and Sale, 1978).

1.3.3 Classification

After the process of simplication the process of classification takes place. Classification modifies data elements or information. This process is to sort data elements in order and simplify unmanageable or complex information. This process includes such things as grouping rivers, towns into categories, or deciding that only three classes of intensity of land utilization for farming are going to be considered. Some of the process are:

(i) The grouping of similar data elements into categories refer to as grading.

(ii) The selection of position and the modification of the data element of that position to create a typical data element, and

(iii) Other forms of typification that may include exaggeration.

Manipulation during classification include class intervals selection and agglomeration routines. One of the classification manipulation is called clustering. Clustering is necessary whenever numerous discrete items characterise a distribution to be mapped, at reduced scale. It is impossible to portray each item in distribution individually. Method of classification by agglomeration are varied. (see Robinson, Morrison and Sale, 1978).

This process revolves around the dimension of data and the potential of symbol design.

1.3.4 Symbolization

After selection, simplification and classification have been applied to the data elements for mapping the process of symbolization takes place. Symbolization is the graphic coding of data elements. It is the transformation of the real world situation to a correction of pictorial or abstract characteristic of its most important features. This process is most critical to the success of any cartographic communication. Symbolization the fact is generalisation to a small degree. The degree of this kind of generalisation varies widely within a map. (see Robinson, Morrison and Sale, 1978).

Basically symbolisation is a coding process and relating the data elements to features on the map. One aid in doing this is to classify the data elements into a two dimensional elements based on:

(i) the existing data type, and

(ii) scale measuremant. The mappable data element can be classified into positional, linear, areal and volumetric and these can be measured on one or more of four levels of measurement: nominal, ordinal, interval and ratio.

Therefore the objective of symbolization is to achieve representation by means of the total generalisation process applied to a particular mapping task.

1.3.5 Induction

Induction or inductive generalisation is a specialized elements in cartographic process. Perhaps it is the most difficult of all steps of generalisation. It is possible by induction to extract additional data when using a map.

It applies particularly to those kind of map-making where the cartographer is performing what will allow him to end up more than he started with. Any overall extension of a system in mapping is inductive generalisation, since it ends up with more than the initial information.

The process or elements of generalisation are selection, simplification, classification, symbolization and induction. The control of generalisation constitute the factors that influence how each factors is performed. The definitions above divide the various manipulation that a cartographer can performed on his selected data elements into five classes depending on the type of transformation involved. (see Robinson, Morrison and Sale, 1978).

2.0 Current Simplification, Classification and Symbolization Of Data Manipulation In Computer Assisted

In this section an elaboration of the more common manipulation may be perform on data during simplification, classification and symbolization aspects of generalisation in computer assisted cartography, and ignoring the process of induction.

2.1 Simplification Manipulation

The simplification process performed with the use of computer enable the cartographer to obtain consistency in generalisation that was impossible before. This consistency can be accomplished quickly and is repeatable; it is useful not only in map preparation but in editing digital files that will be held in storage for future use. This is an important point and a further change in the methodology used with the aid of computer. Simplification process is now used for data prior to entry into the machine storage as to reduce the amount of redundant data captured in the data gathering stage. This is of course no direct counter part in manual production. (see Morrison, 1980).

Simplification can be applied either to a reduction in the scale dimension, that is, reduction for an original data to a smaller representation or a simplified representation at the same scale. Along either of these two dimensions it can be applied to each category in both point the elimination cases and smoothing operation. Usually generalisation in practise is primarily along the dimension of scale reduction and along the dimension of constant scale. It also usually involves data stored as string - both simplification of points and features elimination.

Two cases can be identified in the simplification of data stored as strings of coordinates:

(i) point simplification, and

(ii) features simplification. (see Robinson, Morrison and Sale, 1978).

2.3 Point Simplification

Point Simplification refers to the simplification of a string of coordinate points defining line or an outline of an area. Such simplification takes place by eliminating all points but a chosen few are deemed more important for retention. (see Morrison, 1975).

2.4 Feature Simplification

Feature simplification occurs when many small items of the same class are presented on an area. In this process either a feature is shown in its entirety or it is omitted. The smaller area is omitted. The essential character is retained while detail is omitted. (see Morrison, 1975).

In addition, obviously it is possible to combine point and feature themsekves are points (as result of reduction inn scale), there need be no difference in the simplification of the cases.

2.5 Classification Manipulation

The introduction of sophisticated classification schemes are possible with computer technology. In general, computer has given the cartographer more data manipulation options and at the same time speed their calculations.

There are two type of routines:

(i) the agglomeration of units, and

(ii) the selection of class limits

Both may be applied to point line and area data. Ancillary problems, include the allocation of units area as type or a class, and similarity are for the problems of categorisation of pictured elements. (see Robinson, Sale and Morrison, 1978).

The agglomeration of like units takes place most often by point clustering techniques from tables of location of data point in storage. The agglomeration of line is rare and the agglomeration of areas is part of one type of dasymetric mapping. This is applicable to data stored as pictured element as well. The automation of point clustering technique is possible and at least one software system can purportedly agglomerate irregular areas as in dasymetric mapping. (See Rytheon Co., 1973).

The second case of classification namely class interval selection has perhaps work only on ordinally on higher scaled data. In general, class interval selection has a theoretical base from which to work. Prior to the specification of the class limit hence to decide number of classes for the map. This number of classes is also generalisation.

As the map is the communication of information, three, theoretical bases can be specified in class interval classfication:

(i) the use of critical values,

(ii) the satisfaction of a set of statistical criteria, and

(iii) standardized schemes which enchance map comparison.

The graphic limits controls usually specifies the number of classes. The data quality control along with the desired simplification helps to establish the minimum number or classes that can be effectively used. If the data are of good quality there can be more detail included (i.e. more classes) than the data of less quality.

2.6 Symbolization Manipulation

Map symbols are classed according to point, line and area symbols. Point symbols are used for point data. Line symbols are used for line data, and area symbols are used for areal data. (see K.T. Chang, 1976) Area patterns are used jointly with point data; and the currently popularity of three dimensional diagrams which represent one of the most exciting features in computer assisted mapping. Perhaps the most important exception is the frequent used of qualititative point symbols for area data in aggregate form such as populations. This method is favoured because it is without the visual influence of the size of statistical area. An alternative is to use areal symbols.

Other category of change has been less affected by computer assisted than have many of the other process discussed earlier. It is safe to say that any symbol produced manually can also be produced with computer assistance. Additionally, computer assisted symbolisation can ensure that a symbol is consistently drawn.

The speed with which a data set can be symbolised is greatly increased especially if the symbol is intricate. (see Morrison, 1980).

Point symbol by machine suffers from placement problems. Visually checked manual overide on the computer allows to place the symbols appropriately but slows down the progress. Complete by automatic placement of point symbols, especially in areas of great symbol density has not been perfected, a rather easily operated manual overide check is usually necessary. (see Morrison, 1980).

For line or area symbolization the quality generally equals or exceed the corresponding manual symbolization. Registration problems can be handled easily by equipment driven by computers. The placement problems encounter in point symbols placement are usually not present in line and area symbolizaiton, therefore it can be done by machine production. Hence, the cartographer is free the manual production labour that was required of manual symbolizaiton. Thus, time can be spent ensuring the symbolization being used is correct and perceptually accurate.

3.0 Conclusion

Generalisation belong to the most important decisive concepts of modern cartography. Generalisation method and processess change and improve proportionally to the development of cartographic and the general technical scientific progress. A series of recent publication have as their object a more understanding of the problems.

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